

Serial Number 09/562,995
Filing Date 1 May 2000
Inventor Michael W. Williams

NOTICE

The above identified patent application is available for licensing. Requests for information should be addressed to:

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
CODE 00CC
ARLINGTON VA 22217-5660

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

20010625 116

1 Attorney Docket No. 78622

2

3 BREAK-AWAY MUZZLE CAP RETENTION MECHANISM

4

5 STATEMENT OF GOVERNMENT INTEREST

6 The invention described herein may be manufactured and
7 used by or for the Government of the United States of America
8 for governmental purposes without the payment of any royalties
9 thereon or therefor.

10

11 BACKGROUND OF THE INVENTION

12 (1) Field of the Invention

13 This invention generally relates to a break-away muzzle
14 cap retention mechanism. More particularly, the invention
15 relates to a break-away muzzle cap retention mechanism which
16 utilizes retractable pins in place of shear pins.

17 (2) Description of the Prior Art

18 The current art for break-away muzzle cap retention
19 mechanisms are varied. Certain United States Navy Submarine
20 countermeasures are housed in launch tubes external to a
21 pressure hull where an external surface of the tubes are
22 subjected to depth pressure. An internal part of the tube,
23 where the countermeasure is housed, is maintained dry and at
24 one atmosphere. The muzzle cap is designed to both seal the
25 internal environment of the tube from water, and to release
26 when the internal pressure reaches a predetermined amount.
27 When a command is given for launch, a gas generating device is

1 ignited and pressure quickly increases in the tube until the
2 pressure is great enough to overcome the shear strength of
3 shear pins holding the current muzzle cap in place and depth
4 pressure acting on a face of the muzzle cap. The manufacture
5 of the current shear pins, as well as the installation of the
6 pins, is prohibitively expensive, and necessitates the
7 drilling of holes through the launch tube wall. It is
8 desirable for future launch tubes to be reusable and less
9 expensive, thus a new muzzle cap retention mechanism was
10 needed to both decrease costs, and to avoid the drilling of
11 holes through the launch tube wall, especially if the tube is
12 made of a wound glass fiber composite material instead of the
13 current more commonly used steel material.

14 Thus, a problem exists in the art whereby a consistently
15 operable and inexpensive mechanism for a break-away muzzle cap
16 is not known.

17 The following patents, for example, disclose various
18 types of locking mechanisms, but do not disclose a
19 consistently operable a break-away muzzle cap retention
20 mechanism utilizing a retractable pin mechanism.

21 U.S. Patent No. 4,637,914 to Boyle et al.;

22 U.S. Patent No. 4,743,097 to Bloch;

23 U.S. Patent No. 4,988,248 to Flux;

24 U.S. Patent No. 5,062,826 to Mantovani et al.;

25 U.S. Patent No. 5,180,208 to Lawandi;

26 U.S. Patent No. 5,294,209 to Naka et al.;

27 U.S. Patent No. 5,658,087 to Butkovich et al.;

1 U.S. Patent No. 5,667,330 to Henkel et al.;
2 U.S. Patent No. 5,785,448 to Courgeon et al.; and
3 U.S. Patent No. 5,779,385 to Fechter.

4 Specifically, the patent to Boyle et al. discloses a
5 quick release guide sleeve assembly including an outer sleeve,
6 an inner sleeve axially slidably received in the outer sleeve
7 and having first and second axial positions with respect to
8 the outer sleeve; and a locking mechanism movably mounted on
9 the outer sleeve for frictionally engaging wall surfaces
10 defining an opening for receiving the outer sleeve. The
11 locking mechanism is a locking ball 5, radially movable within
12 a nesting port 4 and has a locking position in which at least
13 part of the locking mechanism projects radially outwardly
14 beyond the external circumferential surface of the outer
15 sleeve. The locking mechanism further has a releasing
16 position in which the locking mechanism is in a radially
17 inwardly withdrawn state relative to the circumferential
18 surface of the outer sleeve. The assembly further includes a
19 camming arrangement carried on the inner sleeve for pressing
20 the locking mechanism into the locking position when the inner
21 sleeve is in the first axial position and for allowing the
22 locking mechanism to assume the releasing position when the
23 inner sleeve is in the second axial position. A spring urges
24 the inner sleeve continuously into the first axial position.

25 The patent to Bloch discloses a clamping device for
26 securing an object within an aperture of a ring member
27 utilizing a shape memory alloy material. The shape memory

1 alloy material contracts when heated and operates to bias pin
2 members inwardly within a central opening of the ring to
3 thereby secure an object such as a canister placed therein.
4 The shape memory alloy material may be in the form of a strap
5 or wire which is easily heated and provides for a fast
6 clamping and release action of the clamping device.

7 Flux discloses a plug-in connector device having a ring-
8 like head portion and a hollow shank. The shank has locking
9 balls which can be held to project outwardly of the shank in a
10 locked condition of the device, and can also move to a
11 retracted position under the control of an axially slidable
12 probe, the movement of which is controlled by an actuator
13 lever on the head portion which can only be moved to release
14 the locking balls from their locked condition on a separate
15 manipulation of a second lever, or in other embodiments a
16 safety catch button, also mounted on the head portion.

17 Mantovani et al. disclose a device for locking the base
18 of a blood centrifugation cell on a retractable generally disc
19 shaped chuck plate. The chuck plate encloses a plurality of
20 elastic locators which extend radially a slight distance from
21 the periphery of the plate. The plate further encloses a
22 plurality of locking means which are biased to remain within
23 the dimensions of the plate at rest and which are radially
24 extendable by centrifugal force to extend beyond the periphery
25 of the plate. An annular locking ring engages the base of the
26 cell and extends around the periphery of the chuck plate. The
27 locking ring has a plurality of internal recesses for

1 initially receiving the elastic locators, and the locking
2 means during centrifugation to secure the cell to the chuck
3 plate.

4 Lawandi discloses a knockdown furniture, such as a chair,
5 having a series of elongated tubular members adapted to be
6 interconnected with quick release automatically locking
7 coupling to form a frame of the furniture. A canvas panel
8 having end sleeves can be mounted to the frame to provide a
9 support surface, such as a seat panel, of the furniture.
10 Pockets are provided on one side of the support panel, such as
11 the underside of the seat panel, in order to receive the
12 individual tubular members when the furniture is disassembled.
13 A zipper which is provided at opposed end edges of the support
14 panel is used to form a sleeve therewith which contains the
15 pockets and thus the tubular members, thereby resulting in a
16 compact storage of the dismantled furniture.

17 Naka et al. discloses an attaching device for attaching a
18 tool to a tool manipulation arm and having a first attachment
19 member affixed to the tool manipulation arm which is adapted
20 to engage a second attachment member affixed to the tool. The
21 first attachment member includes a locking device which is
22 engageable with a cam surface formed on the second attachment
23 member such that the engagement urges a seating surface
24 defined on the first attachment member and a mounting surface
25 defined on the second attachment member into sealing contact
26 with each other. The seal effected by the contact of these
27 surfaces hermetically seals the locking device such that it is

1 not susceptible to contamination by the dust water, sand,
2 ships, oil, etc, which may be present in the working
3 environment in which the robot is located.

4 The patent to Butkovich et al. discloses a locking
5 mechanism in the form of locking balls for releasably fixing
6 an externally splined power take-off shaft to an output shaft
7 of off-highway equipment such as a tractor. The output shaft
8 has a hollow, integrally splined hub portion adapted to
9 axially receive the externally splined power take-off shaft to
10 prevent relative rotational movement between the power take-
11 off and output shafts. The locking mechanism includes a
12 locking member supported within a radial opening in the power
13 take-off shaft so as to be radially moveable between an outer
14 locking position and an inner unlocking position. In the
15 outer locking position, the locking member is engageable with
16 a recess formed in the hub portion of the output shaft to
17 prevent relative axial movement between the power take-off
18 shaft and the output shaft. In the inner unlocking position,
19 the locking member is disengaged from the recess in the output
20 shaft to permit such relative axial movements. An elongated
21 actuator is positioned within an inner bore of the power take-
22 off shaft and has a cam surface thereon. The actuator is
23 movable between a first position in which the actuator
24 operably maintains the locking member in its locking position,
25 and a second position which permits radial movement of said
26 locking member to its unlocking position. Upon return of the
27 actuator to the first position, the cam surface operably

1 engages the locking member to move the locking member to its
2 locked position.

3 Henkel et al. discloses a locking mechanism in the form
4 of a locking detent or ball for releasably fixing an
5 externally splined power take-off shaft to an output shaft for
6 off-highway equipment such as a tractor. The output shaft has
7 a hollow, internally spined hub portion adapted to axially
8 receive the externally splined power take-off shaft to prevent
9 relative rotational movement between the power take-off and
10 output shafts. The locking mechanism includes a locking
11 member guided within a radial opening on the output shaft so
12 as to be radially movable between an inner locking position
13 and a outer unlocking position. In the inner locking position
14 the locking member is engageable with a recess formed on the
15 power take-off shaft to prevent relative axial movement
16 between the power take-off shaft and the output shaft. In the
17 outer unlocking position, the locking member is disengaged
18 from the recess in the output shaft to permit such relative
19 axial movement. An actuator is positioned about an exterior
20 of the output shaft and is movable between a first position in
21 which the actuator operably maintains the locking member in
22 its locking position, and a second position which permits
23 radial movement of the locking member to its unlocking
24 position.

25 Courgeon et al. discloses a device for coupling two
26 shafts adapted to turn about a common axis and includes a
27 rotational coupling system associated with an axial retaining

1 system. The rotational coupling system includes conjugate
2 profiles at the ends of the shafts. The axial retaining
3 system comprises a two-part sleeve coupled axially to the
4 shaft and cooperating with a spring disposed inside the
5 sleeve. The end of each shaft is surrounded by the sleeve.
6 The spring operates after releasing an arming system including
7 studs on the sleeve cooperating with cams at the end of one of
8 the shafts.

9 The patent to Fechter discloses a coupling for axially
10 fixing a hub on a shaft and has locking members slidable in
11 slots of the hub and which are engaged in recesses in the
12 shaft by a collar which holds the locking members in the
13 recesses so as to fix the hub axially on the shaft. In a
14 released position, a shoulder on the collar catches behind a
15 ledge formed on the hub but only when the shaft is removed
16 from the hub. When the shaft is in the hub, it cams against
17 unlocking members in the form of balls which prevent the
18 collar from being tilted so as to engage the collar shoulder
19 with the ledge on the hub. One embodiment for a later
20 application has a collar biasing spring radially inside of the
21 collar and axially between the locking members and the shaft
22 entry end of the hub. An embodiment for a smaller application
23 has the spring radially outside of the hub and on the opposite
24 axial side of the locking elements. A shield is provided in
25 this embodiment to enclose the spring chamber.

26 It should be understood that the present invention would
27 in fact enhance the functionality of the above patents by

1 providing a break-away muzzle cap retention mechanism as in
2 the present invention having a retractable pin mechanism which
3 is both effective and cost-efficient.

4

5

SUMMARY OF THE INVENTION

6 Therefore it is an object of this invention to provide a
7 break-away muzzle cap retention mechanism.

8 Another object of this invention is to provide a break-
9 away muzzle cap retention mechanism that releasably secures a
10 muzzle cap to a launch tube.

11 Still another object of this invention is to provide a
12 break-away muzzle cap retention mechanism that releasably
13 secures the muzzle cap to the launch tube with retractable
14 pins.

15 A still further object of the invention is to provide a
16 break-away muzzle cap retention mechanism for releasably
17 securing the muzzle cap to the launch tube with reusable
18 retractable pins.

19 Yet another object of this invention is to provide a
20 break-away muzzle cap retention mechanism which is simple to
21 manufacture and easy to use.

22 In accordance with one aspect of this invention, there is
23 provided a break-away end cap for a closed tube which includes
24 a tube member of predetermined characteristics and an end cap
25 member for releasably securing the open end of the tube
26 member. An annular recessed groove is formed in the inner
27 surface of the tube member. The end cap member includes an

1 outer flange portion having an outer peripheral surface
2 consistent in diameter with an outer diameter of the tube
3 member and a body portion depending from the outer flange
4 portion. At least one recessed opening is laterally formed
5 within the body portion with a pilot hole formed at the base
6 end of each recessed opening. A normally biased spring member
7 is seated in a base of the recessed opening and a retractable
8 pin is positioned over the normally biased spring member. The
9 retractable pin has an outer beveled surface end which seats
10 within the annular recessed groove and is held therein with
11 the normally biased pressure of the spring member until a
12 force greater than the normal bias of the spring member is
13 applied against the inner surface of the end cap.

14
15 BRIEF DESCRIPTION OF THE DRAWINGS

16 The appended claims particularly point out and distinctly
17 claim the subject matter of this invention. The various
18 objects, advantages and novel features of this invention will
19 be more fully apparent from a reading of the following
20 detailed description in conjunction with the accompanying
21 drawings in which like reference numerals refer to like parts,
22 and in which:

23 FIG. 1 is a side sectional view of a prior art connection
24 for a muzzle end cap;

25 FIG. 2 is a top plan view of a prior art connection for a
26 muzzle end cap taken along line 2-2 of FIG. 1;

1 FIG. 3 is a side sectional view of a preferred embodiment
2 of a connection for an end cap according to the present
3 invention; and

4 FIG. 4 is a top plan view of a connection for an end cap
5 according to the present invention taken along line 4-4 of
6 FIG. 3.

7

8 DESCRIPTION OF THE PREFERRED EMBODIMENT

9 In general, the present invention is directed to a break-
10 away muzzle cap retention mechanism used to secure break-away
11 muzzle caps on submarine countermeasure launch tubes before
12 the countermeasures are launched. The mechanism can also be
13 used with muzzle caps on surface vessel torpedo tubes, or any
14 tube that requires an end to break-away at a prescribed
15 internal pressure.

16 Referring first to the subject matter of FIGS. 1 and 2,
17 there is shown a sectional view and top plan view,
18 respectively, of a prior art end cap connection.

19 In particular, the prior art end cap connection includes
20 a launch tube 10 of a substantially cylindrical shape and
21 having an inner peripheral surface 12 and an outer peripheral
22 surface 14. The launch tube 10 is further defined by an open
23 end 16 from which a missile (not shown) is launched.

24 An end cap 18 is seated within the open end 16 of the
25 launch tube 10 for selectively sealing the launch tube 10.
26 The end cap 18 includes an outer flange member 20 defining an
27 outer surface of the end cap 18 and a body portion 22

1 depending from the flange member 20. The depending body
2 portion 22 terminates in an internal face 30 of the end cap
3 18. The internal face 30 of the end cap includes a cut out
4 portion 32 of a substantially cylindrical shape as shown.
5 Each of the outer flange member 20 and depending body portion
6 22 are cylindrical in their outer circumference and a diameter
7 of the body portion 22 is less than a diameter of the outer
8 flange member 20. The diameter of the depending body portion
9 22 is such that an outer peripheral surface thereof
10 corresponds to a diameter of an inner peripheral surface 12 of
11 the launch tube 10.

12 The depending body portion 22 of the end cap 18 includes
13 an outer circumferential groove 24 formed therearound. The
14 outer circumferential groove 24 is formed adjacent the distal
15 or internal face 30 of the end cap 18. An O-ring 26 is seated
16 within the outer circumferential groove 24 and assists in the
17 friction fit of the depending body portion 22 against the
18 inner peripheral surface of the launch tube 12. The end cap
19 10 is physically secured to the launch tube 10 by at least a
20 pair of shear pins 28. The shear pins 28 are inserted through
21 the launch tube 10 and into the end cap 18 via preformed
22 openings 34 and 36 of the launch tube 10 and end cap 18,
23 respectively.

24 Thus FIGS. 1 and 2 reflect the current muzzle cap 18 to
25 launch tube 10 interface and connection by means of shear pins
26 28. Water tight sealing is achieved through the O-ring 26.
27 The shear pins 28 are press fit into the close tolerance holes

1 34, 36 drilled through the launch tube 10 and into the muzzle
2 cap 18 previously assembled to the launch tube 10. When the
3 internal tube pressure increases during the launch transient
4 of a missile or the like (not shown), the force acting on the
5 internal face 30 of the muzzle cap 18 increases until there is
6 enough force to shear the pins 28 and overcome any hydrostatic
7 pressure due to the depth of launch for the muzzle cap 18 to
8 break-away from the launch tube 10.

9 Turning now to the subject matter of the present
10 invention as shown in FIGS. 3 and 4, there is shown an
11 inventive muzzle cap 40 for use with a corresponding launch
12 tube 42.

13 The launch tube 42 of the present invention includes a
14 substantially cylindrical housing having an inner peripheral
15 surface 49, an outer peripheral surface 46, and an open end
16 48. A significant difference exists in the present invention,
17 however, in the provision of an annular recessed groove 50 on
18 the inner peripheral surface 49 of the launch tube 42.

19 Functioning of the annular recessed groove 50 will be
20 described in further detail in connection with the muzzle cap
21 40 in the following.

22 The muzzle cap or end cap 40 is seated within the open
23 end 48 of the launch tube 40 for selectively sealing the
24 launch tube 42. The muzzle cap 40 includes an outer flange
25 member 52 defining an outer surface of the muzzle cap 40 and a
26 body portion 54 depending from the flange member 52. The
27 depending body portion 54 terminates in an internal face 56 of

1 the muzzle cap 40. The internal face 56 of the muzzle cap 40
2 is planar as shown. Each of the outer flange member 52 and
3 depending body portion 54 are cylindrical in their outer
4 circumference and a diameter of the body portion 54 is less
5 than a diameter of the outer flange member 52. The diameter
6 of the depending body portion 54 is such that an outer
7 peripheral surface thereof corresponds to a diameter of the
8 inner peripheral surface 49 of the launch tube 42.

9 The depending body portion 54 of the muzzle cap 40
10 includes an outer circumferential groove 58 formed
11 therearound. The outer circumferential groove 58 is formed
12 adjacent the outer flange portion 52 of the end cap 40. An O-
13 ring 60 is seated within the outer circumferential groove 58
14 and assists in the friction fit of the depending body portion
15 54 against the inner peripheral surface 49 of the launch tube
16 42.

17 A further inventive feature is found in the securement of
18 the muzzle cap 40 to the launch tube 42. In particular, the
19 body portion 54 of the muzzle cap 40 includes at least one
20 recessed opening 62 formed transverse, and preferably
21 perpendicular, to outer peripheral wall surface 55 of the body
22 portion 54. Even further, within the recessed opening 62,
23 there is drilled a threaded or planar pilot hole 64 which is
24 positioned substantially centrally longitudinally of the
25 recessed opening 62. The pilot hole 64 extends into the body
26 portion 54 of the muzzle cap 40 a greater distance than the
27 recessed opening 62.

1 A normally biased spring member 66 is seated within the
2 recessed opening 62 of the muzzle cap 40, and retractable pin
3 68 is positioned over the spring member 66 so as to extend
4 beyond the outer peripheral wall surface 55 of the body
5 portion 54.

6 The spring member 66 is shown as being a coiled type
7 spring, however, it should be understood that the shape of the
8 spring is not intended to be limiting of the invention.

9 The retractable pin 68 includes a base end 70 in surface
10 contact with the spring member 66 and an outer chamfered or
11 beveled end 72 opposing the base end 70. The beveled end 72
12 is formed so as to be a substantially conical bevel, however,
13 it is understood that modifications of the bevel shown may be
14 suitable for the intended purpose and function of the
15 invention. The retractable pin 68 further includes a
16 longitudinal opening 74 formed therethrough in alignment with
17 an opening in the spring member 66. The longitudinal opening
18 74 is stepped at 76 adjacent the outer end and within the
19 conical shape thereof for limiting insertion of a retaining
20 member 78.

21 The retaining member 78 is a threaded screw, anchor nail,
22 or the like, which is inserted into the longitudinal opening
23 74 of the retractable pin 68 and through the spring to a point
24 of anchoring within the pilot hole 64 of the body portion 54.
25 The retaining member 78 includes an anchoring end 80 which may
26 be provided with screw threads or smooth as necessary for

1 operation of the device, and a head end 82 which seats against
2 the stepped portion 76 of the longitudinal opening 74.

3 Thus, the launch tube 42 is connected with the muzzle cap
4 40 by way of the retractable pins 68 in contact with the
5 springs 66. The retractable pins 68 are held in place during
6 the assembly process by the recessed anchoring member 78. A
7 water tight seal is provided by the O-ring 60.

8 A tool may be used to force the muzzle cap 40 onto the
9 launch tube 42 by applying a force to the external face or
10 outer flange portion 52 of the muzzle cap 40. The beveled
11 edge 72 on the retracting pins 68 will contact the launch tube
12 42, causing a force on the pins 68 such that a compressive
13 load is applied to the underlying springs 66. The beveled
14 edge 72 extends around the circumference of the retractable
15 pin 68 in order to allow for the beveled edge 72 to engage a
16 surface in any rotational orientation. When the retractable
17 pins 68 and springs 66 are recessed such that the total
18 diameter of the muzzle cap 40 is less than the internal
19 diameter of the launch tube 42, the muzzle cap 40 is free to
20 move further in to the launch tube 42. When the muzzle cap 40
21 moves into the launch tube 42 such that the retractable pins
22 68 are in line with the annular recessed groove 50 in the
23 launch tube 42, the load on the springs 66 will decrease,
24 causing the springs 66 to expand and to push the retractable
25 pins 68 into the annular recessed groove 50, effectively
26 locking the muzzle cap 40 into the launch tube 42.

1 Upon an increase of internal tube pressure during a
2 launch transient, the force acting on the internal face 56 of
3 the muzzle cap 40 increases to overcome any hydrostatic
4 pressure due to the depth of launch and forces the beveled
5 edge 72 of the retractable pins 68 against the edge of the
6 annular recessed groove 50 in the launch tube 42. The force
7 on the beveled edge 72 causes the retractable pin 68 to apply
8 a load to the springs 66, causing the springs 66 to contract
9 and thus lower the retractable pin 68. Once the retractable
10 pins 68 retract such that the total diameter of the muzzle cap
11 40 is less than the inner diameter 49 of the launch tube 42,
12 and hydrostatic pressure is overcome, the muzzle cap 40 breaks
13 away from the launch tube 42. The springs 66 are sized in
14 such a way that the muzzle cap 40 will break-away at a pre-
15 determined internal pressure of the launch tube 42 relative to
16 the hydrostatic pressure on the muzzle cap.

17 The present invention will significantly decrease overall
18 manufacturing costs, and will negate the need to bore a hole
19 in the launch tube, thus allowing for less expensive composite
20 launch tube use.

21 The present invention may be used in any application that
22 requires a part to break-away when there is a differential
23 pressure applied across the part. One immediate use could be
24 on surface vessel torpedo tubes, which utilize a muzzle cap
25 much like the submarine countermeasure launch tube's muzzle
26 cap for which the present invention was intended.

1 Finally, it is anticipated that the invention herein will
2 have far reaching applications other than those of underwater
3 vehicles.

4 This invention has been disclosed in terms of certain
5 embodiments. It will be apparent that many modifications can
6 be made to the disclosed apparatus without departing from the
7 invention. Therefore, it is the intent
8 to cover all such variations and modifications as come within
9 the true spirit and scope of this invention.

3 BREAK-AWAY MUZZLE CAP RETENTION MECHANISM

5 ABSTRACT OF THE DISCLOSURE

6 A break-away end cap assembly includes a tube member of
7 predetermined characteristics and an end cap member for
8 releasably securing the open end of the tube member. An
9 annular recessed groove is formed in the inner surface of the
10 tube member. The end cap member includes an outer flange
11 portion having an outer peripheral surface consistent in
12 diameter with an outer diameter of the tube member and a body
13 portion depending from the outer flange portion. At least one
14 recessed opening is laterally formed within the body portion
15 with a pilot hole formed at the base end of each recessed
16 opening. A normally biased spring member is seated in a base
17 of the recessed opening and a retractable pin is positioned
18 over the normally biased spring member. The retractable pin
19 has an outer beveled surface end which seats within the
20 annular recessed groove and is held therein with the normally
21 biased pressure of the spring member until a force greater
22 than the normal bias of the spring member is applied against
23 the inner surface of the end cap.

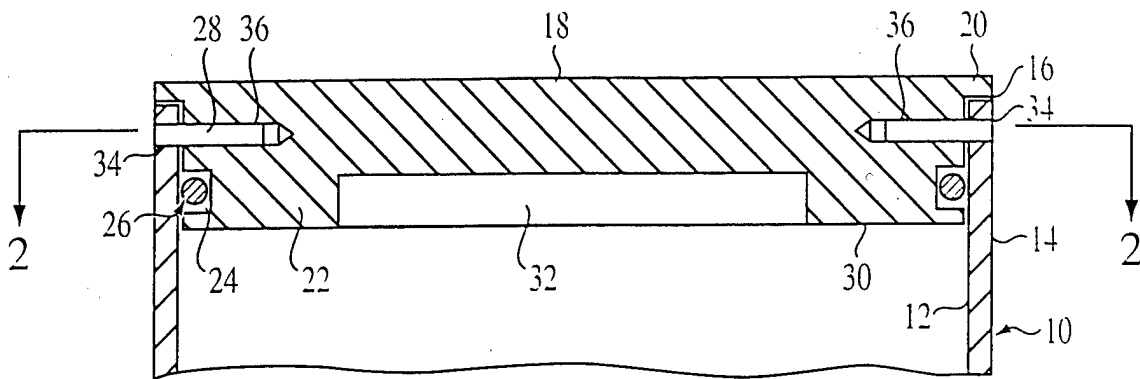


FIG. 1
PRIOR ART

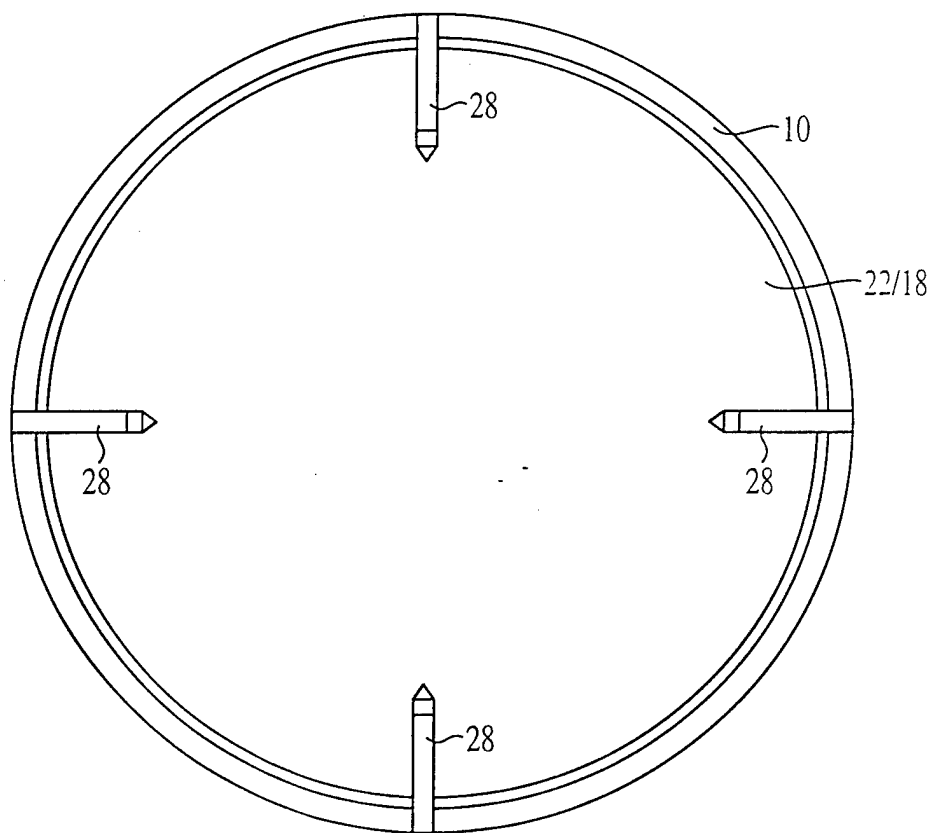


FIG. 2
PRIOR ART

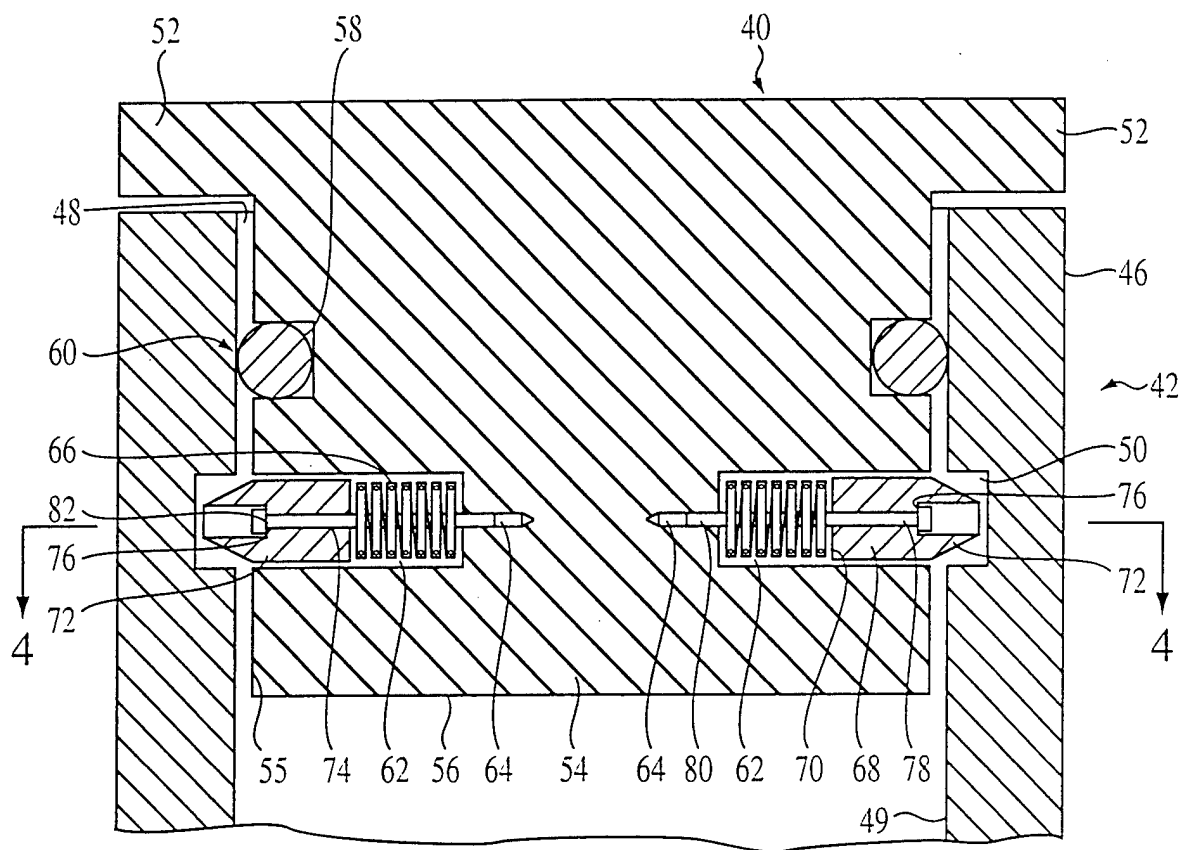


FIG. 3

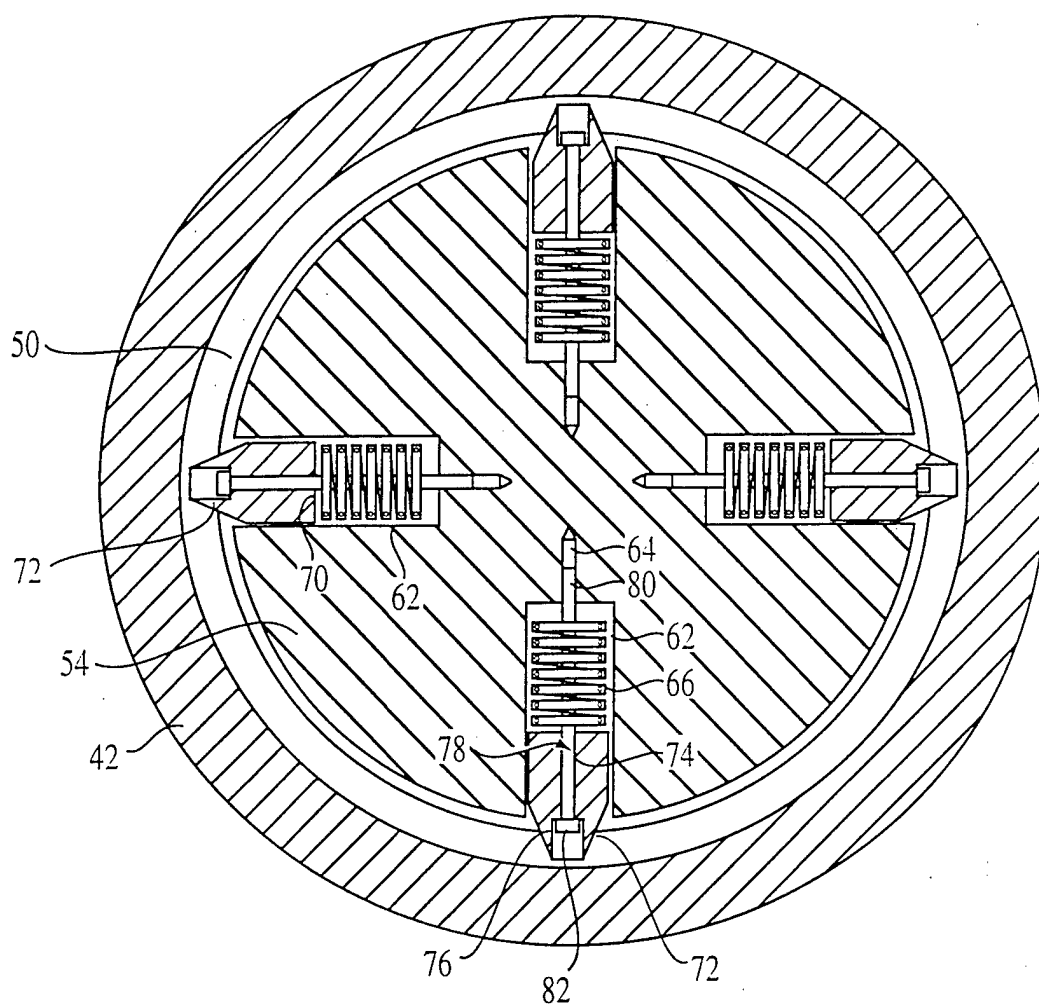


FIG. 4